# Life-Cycle Acquisition Management in a Collaborative Environment

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# Disclaimer

***(think I need to have this)***

- This briefing represents my personal opinions, and is based on my background and experiences

# Outline

- Modeling and Simulation and Collaborative Environment
- Old way versus new way
- Spiral Development
- M&S and Systems Engineering
- Modeling and Simulation Examples
- State of affairs
- Summary

# Bottom Line Up Front

- Modeling and Simulation (M&S) are critical tools in today’s environment.
- An Integrated Data Environment (IDE) and common development tools are essential to today’s programs (collaborative environment).
- A healthy M&S program must evolve out of a robust systems engineering process and can not take on a life of its own.

***Today’s programs will not be successful without a Robust M&S program and collaborative environment***

# Modeling and Simulation and a Collaborative Environment

# Must Start Early

- A robust Systems Engineering process and planning for M&S must be part of S&T programs
- It is not too early to establish a collaborative environment in S&T and start capturing critical data for:
  - ✓ Systems Engineering
  - ✓ Cost
  - ✓ Force and system effectiveness
  - ✓ Training concept
  - ✓ CONOPS
  - ✓ Early M&S is not just experiments
  - ✓ We have all seen the chart that shows a large % of costs are locked in prior to Milestone one based on technology development/materiel solution

# What Drives Good M&S

- Plan to use M&S across all aspects of Life-Cycle
- Systems Engineering
- Program Management requirements
- Collaborative Environment
- Starting early-early and often
- Program Risk
- Resources
- Combat Development

# What is a Collaborative Environment?

- An integrated Data Environment
- Common Developments tools
- Work flow process
- With a good collaborative environment, you will achieve data management and configuration management

***Need to establish a good user jury to make sure the Collaborative Environment meets the teams needs***

# Integrated Data Environment

- The Integrated Data Environment enables IPPD by providing:
  - ✓ A single, secure source of program information to all team members regardless of geographical location
  - ✓ includes automation of critical processes
  - ✓ Everyone is working form the same sheet of music
- The Common Development Environment minimizes product development risk through:
  - ✓ Enabling virtual prototyping & product development through consistent engineering data formats

# M&S is Critical for all Aspects of the Life-Cycle

- System Development/Design (all aspects)
- Doctrine Development/CONOPS
- System and Force Analysis
- Training
- Operation and support
- Test and Evaluation

***Simulation Support Plan and process is a working document that will mature with the program evolution, much like other critical program management documents***

# Simulation-Based Development

## Continuously Verifies and Optimizes the Design

System Engineering

System Integration

Total Life Cycle Support

S/W Architecture

Program Managemen

S/W Integration

Mechanical Design

MANPRINT

Electrical Design

Test & Evaluation

Force Effectiveness Analysis

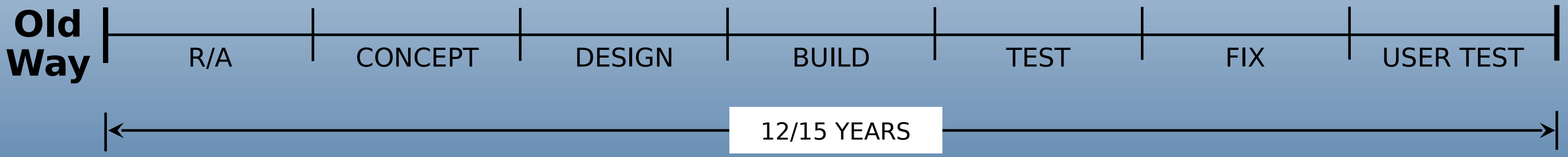
Training

***Simulation-based development concurrently and continuously addresses the system’s complete acquisition life cycle***

# Old Way Versus New Way and Spiral Development

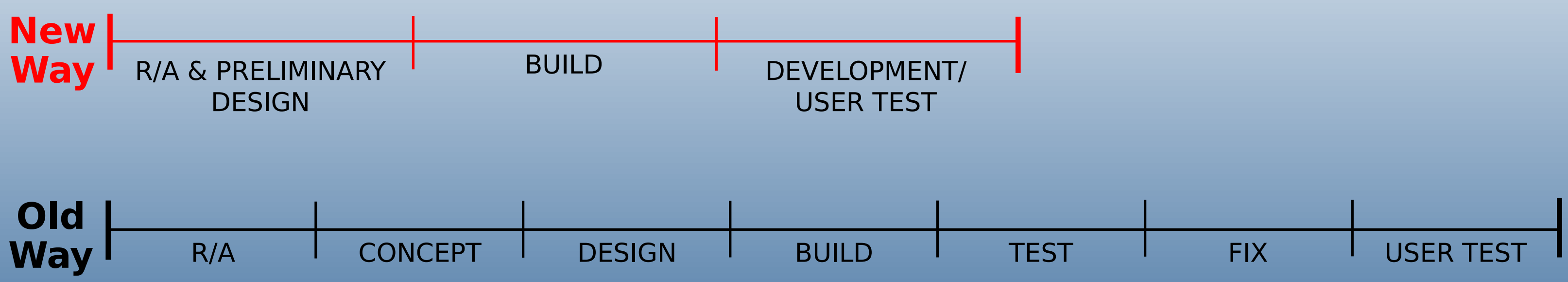
# The Old Way of Doing Business

- The Development Cycle was serial (Developer/Tester/User) and based on “Test-Fix-Test”
- Limited User involvement until it was time to test the hardware



# Impact of Simulation Based Development

- The new development cycle is parallel (Developer+Tester+User)
- “Test-Fix-Test” still occurs but in a virtual versus a real environment, “Model-Test-Model”.



New Way

R/A & PRELIMINARY DESIGN

BUILD

DEVELOPMENT/ USER TEST

Old Way

R/A

CONCEPT

DESIGN

BUILD

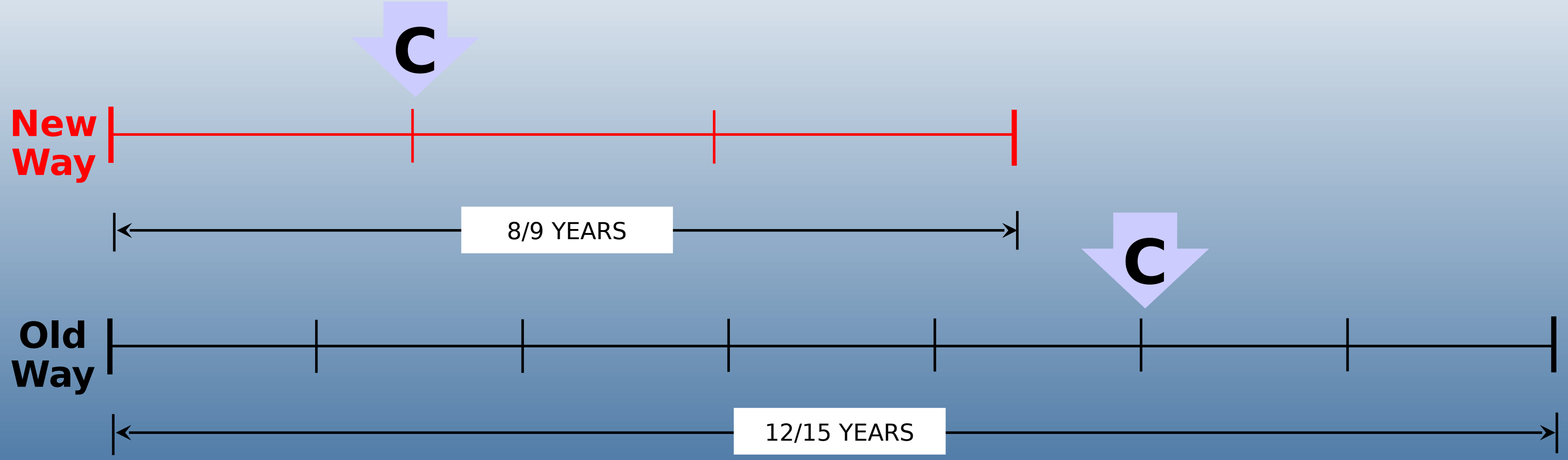
TEST

FIX

USER TEST

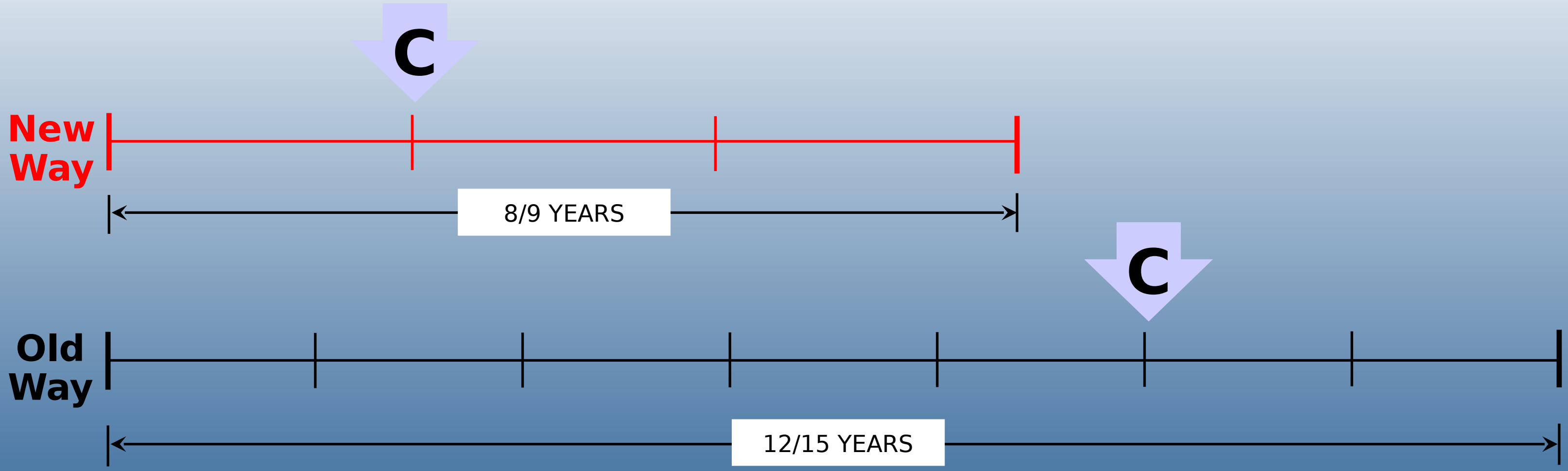
# Key Benefits of Simulation Based Development

- Allows the development cycle to be shortened
- Establishes a high level of confidence much earlier in development that the design will satisfy the requirement
- In today’s environment can’t afford not to do it



# Implications of Simulation Based Development

- The OPM, User and the stake holders must partner with the Developer through the entire program
- Critical program information exists in large databases which must be carefully managed and readily accessible by all partners
- Government is an integral part of the Intergraded Development Teams



# M&S, collaborative Environment and Spiral Development

- Need a comprehensive Collaborative Environment to support Spiral Development
- All efforts in support of all spirals needs to be Integrated and Evaluated in a single collaborative environment
- A sound Spiral Development program requires a robust Systems Engineering effort supported by a healthy M&S program

# Traditional Acquisition System: Formula for Problems

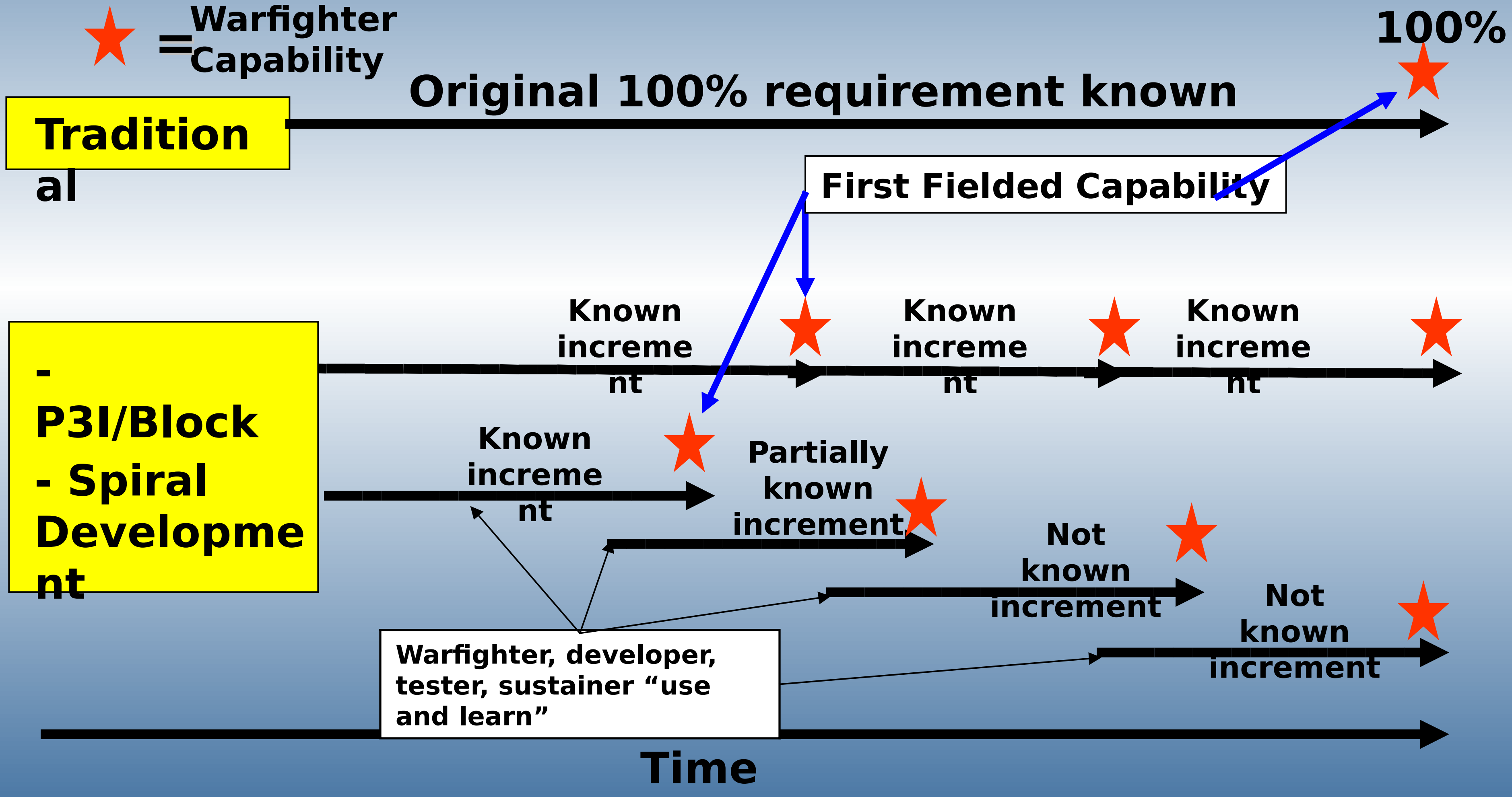
- Serial, “big-bang” solution drives cycle time
- Difficult to adjust requirements to reflect asymmetric threats or warfighter “use and learn” experience
- No requirement for collaboration among various players (users, acquirers, testers, etc.)
- Technology reach too long and process lacks flexibility for timely insertion
- Too much time for things to go wrong (budget instability, schedule changes, cost increases, etc.)

# Evolutionary Acquisition

- An incremental development strategy
- More than one flavor of evolutionary acquisition
  - Pre-planned product improvements
  - Block upgrades
  - Spiral development
- Spiral differs from others
  - Each increment may have multiple spirals
  - Each spiral yields less than 100% solution (except the last)
  - Each development spiral typically much shorter
  - Spirals apply to new or immature system

***olid program plan, robust systems engineering, adequate budge***
***d a realistic schedule are the foundation for a successful progra***

# Traditional, Block, and Spiral Development



★ = Warfighter Capability

100%

Original 100% requirement known

Traditional

First Fielded Capability

- P3I/Block

- Spiral Development

Known increment

Known increment

Known increment

Known increment

Partially known increment

Not known increment

Not known increment

Warfighter, developer, tester, sustainer “use and learn”

Time

# Focus of Implementing Spiral Development

- **Deliver capability to the warfighter faster**
  - ✓ **Deliver in increments that meet the warfighter needs**
  - ✓ **Something in hand in 2-4 years**
- **Increase collaboration between warfighters, acquirers, and developers**
  - ✓ **Requirements evolve from user learning**
- **Increase accuracy of budget estimates for current years**
  - ✓ **Create mechanism for incremental budget investment decision based on results**
- **Increase focus on aligning and transitioning technology**
  - ✓ **Incorporation of technologies into spirals is related to risk**

***FIELD TODAY'S TECHNOLOGY -- TODAY!***
***NOT YESTERDAY'S TECHNOLOGY -- TOMORROW!***

# Implementation Issues with Spiral Development

- Spiral requirements and user angst
  - ✓ 100% solution in first spiral
  - ✓ Firming requirements without understanding implications
- Over promising by developers, technologists
- Operational testing
- Contracting Strategy
- Competition with legacy programs
- Supportability
- Budgeting
- Total development cost
- Congressional acceptance

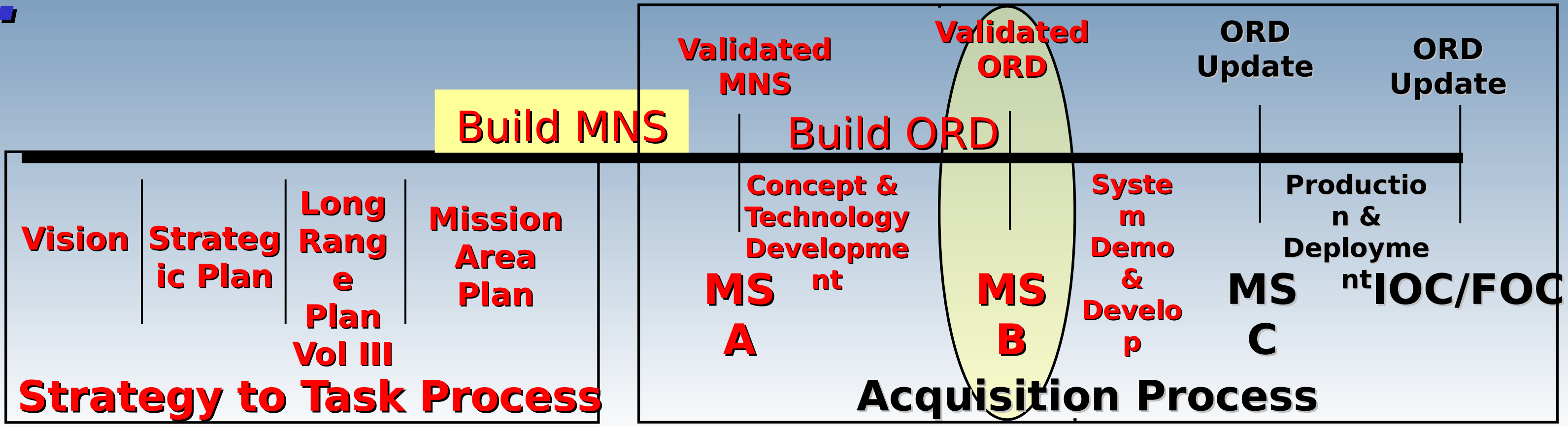
# Finishing the Reform Foundation

- Collaborative Spiral Development targeted as key to:
  - ✓ Reducing cycle times
  - ✓ Increasing credibility on cost/schedule/performance
- Current programs are attempting to chart a new course, emphasizing:
  - ✓ Collaborative requirements/program management
  - ✓ Seamless verification
  - ✓ Technology maturation and focus

***boratively-Developed, Effects-Based, Capability-Focused Require***
***--- Foundation for Spiral Development***

# New Process

## Now:



Build MNS

Build ORD

Validated MNS

Validated ORD

ORD Update

ORD Update

Vision

Strategic Plan

Long Range Plan Vol III

Mission Area Plan

Strategy to Task Process

MS A

Concept & Technology Development

MS B

System Demo & Develop

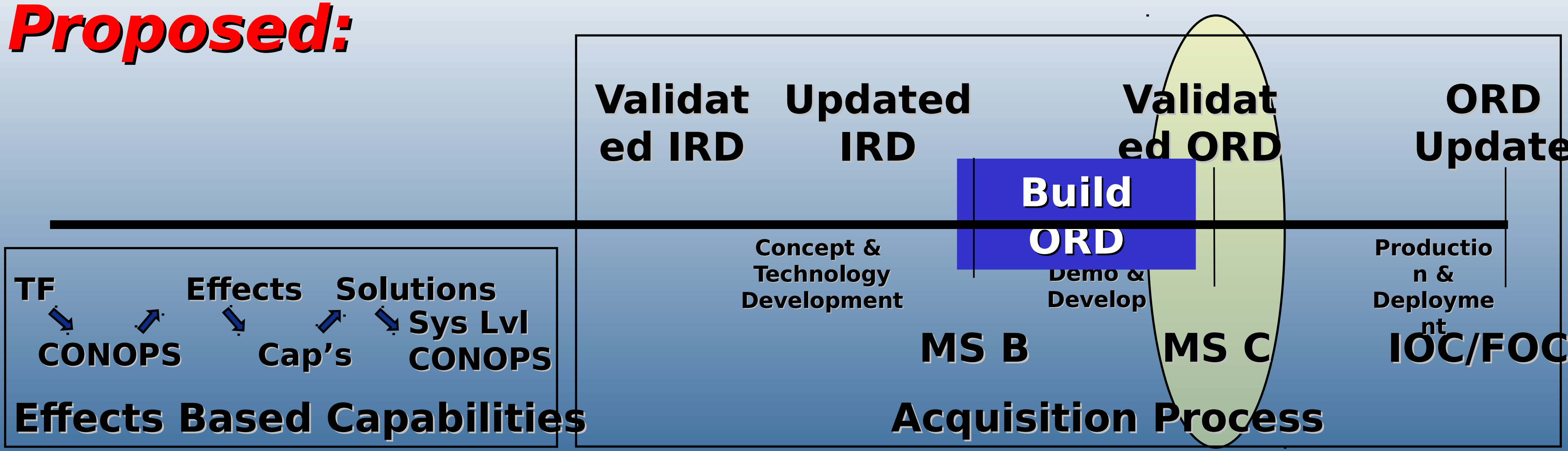
MS C

Production & Deployment

IOC/FOC

Acquisition Process

## Proposed:



Validated IRD

Updated IRD

Validated ORD

ORD Update

Build ORD

TF ↘ CONOPS ↗ Effects ↘ Cap's ↗ Solutions ↘ Sys Lvl CONOPS

Effects Based Capabilities

Concept & Technology Development

MS B

Demo & Develop

MS C

Production & Deployment

IOC/FOC

Acquisition Process

# Collaborative Requirements & Program Management

- Expectations management – Harmonize requirements with reality
  - ✓ Program and requirements concurrent and collaborative
- Goal is total credibility
  - ✓ Have high confidence in program estimates
  - ✓ Promise = results
  - ✓ Don’t say what we don’t know
- Build “Collaborative Requirements and Courses of Action (COA) Processes”
  - ✓ Foundation for upfront continuous collaboration and planning by the warfighter, MDA, technologists, developers/acquirers, sustainers, budgeters, and testers
  - ✓ Warfighter with acquirer support develops Interim Requirements Document (IRD) focused on needed capabilities and CONOPs
  - ✓ MDA/PM with Warfighter develops firm COAs presenting several options – including, schedule, costs, and performance commitments for each COA
  - ✓ Warfighter picks desired COA – MDA and MAJCOM Commander sign
- Expected Outcome
  - ✓ Shared expectations by warfighter and MDA on strategy, schedule, cost, and performance
  - ✓ Incremental/spiral requirements yield faster delivery

# In Spiral Development Requirements Still a Concern

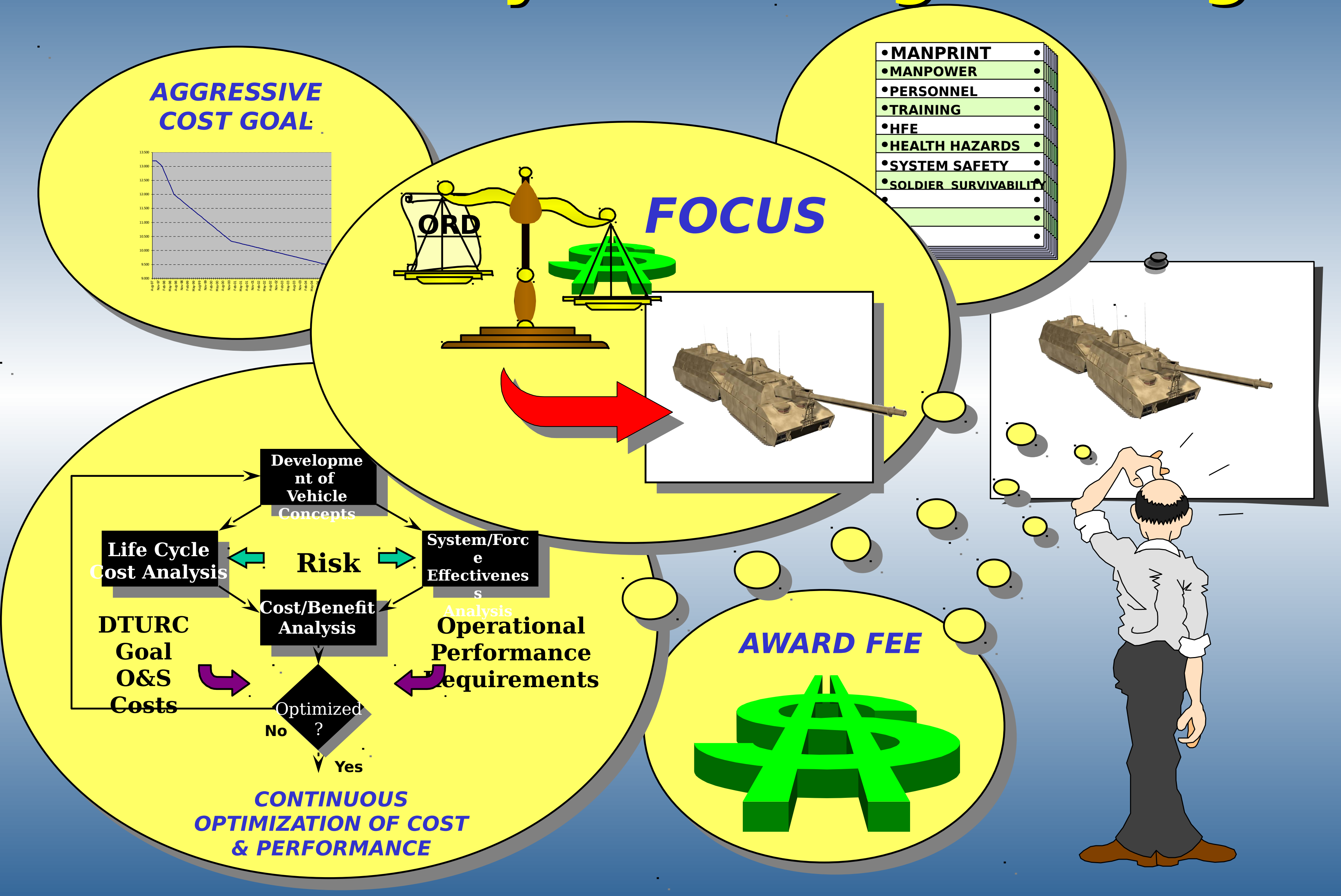
- Spiral Development will get new capability quickly into warfighters hands
  - ✓ Less than 100% capability in first spiral and “use-and-learn” development concepts are key to success, but, as yet, are not fully institutionalized
- Requirements are the foundation critical to increasing credibility/setting mutual expectations
  - ✓ Collaboration is the key
  - ✓ Multiple meetings taking place to improve collaboration, but we must to continue to work this process
- Both requirers and acquirers still want too much specificity in requirements
  - ✓ Effects-based, capability-focused requirements must become the norm

# What Spiral Development Can Offer
# Higher Probability of Success

- Better Technology
  - ✓ Spiral development allows flexibility to insert latest technology
- Better Cost Estimates
  - ✓ Program separated into smaller manageable chunks in-line with technology half-life
- Better Scheduling
  - ✓ Bite-sized chunks make schedule predictable
  - ✓ Less changes since shorter time (Administration, world-events, etc.)
- Mutual expectations on spiral content, cost, and schedule
  - ✓ Common objectives agreed to up-front between all stakeholders

***A Collaborative and Credible Acquisition Process***

# M&S and Systems Engineering



AGGRESSIVE COST GOAL

- MANPRINT
- MANPOWER
- PERSONNEL
- TRAINING
- HFE
- HEALTH HAZARDS
- SYSTEM SAFETY
- SOLDIER SURVIVABILITY

FOCUS

Development of Vehicle Concepts

Life Cycle Cost Analysis

Risk

System/Force Effectiveness Analysis

Cost/Benefit Analysis

Optimized ?

DTURC Goal O&S Costs

Operational Performance Requirements

CONTINUOUS OPTIMIZATION OF COST & PERFORMANCE

AWARD FEE

# Systems Engineering Examples

- System Level System Engineering
  - ✓ Mission Analysis
  - ✓ Requirements Analysis/Specifications
  - ✓ System Level Control and Analysis
  - ✓ Integration of the Software and Specialty Engineering
- Force and System Effectiveness
- Software Engineering
  - ✓ Developing and Updating the SW Architecture
  - ✓ Developing and Maintaining the SW Development Environment
- Specialty Engineering
  - ✓ TPM Management
  - ✓ Risk Management
  - ✓ Life Cycle Cost/Design to Cost Management
  - ✓ Human Factors Engineering
  - ✓ MANPRINT
  - ✓ Safety and Health Hazard Engineering
  - ✓ Survivability Engineering
  - ✓ Producibility
  - ✓ Configuration Mngmt and Status Accounting

# Systems Engineering Examples (Cont.)

- System Concept and System Layout
  - ✓ Maintaining the Master Model
  - ✓ Developing the Industrial Concept
  - ✓ System Survivability Concept
  - ✓ System Structures
- System Design, Integration and Control
  - ✓ Interface Control
  - ✓ System Level Modeling and Simulation
  - ✓ Software Integration
- System Integration Lab - Development & Operation

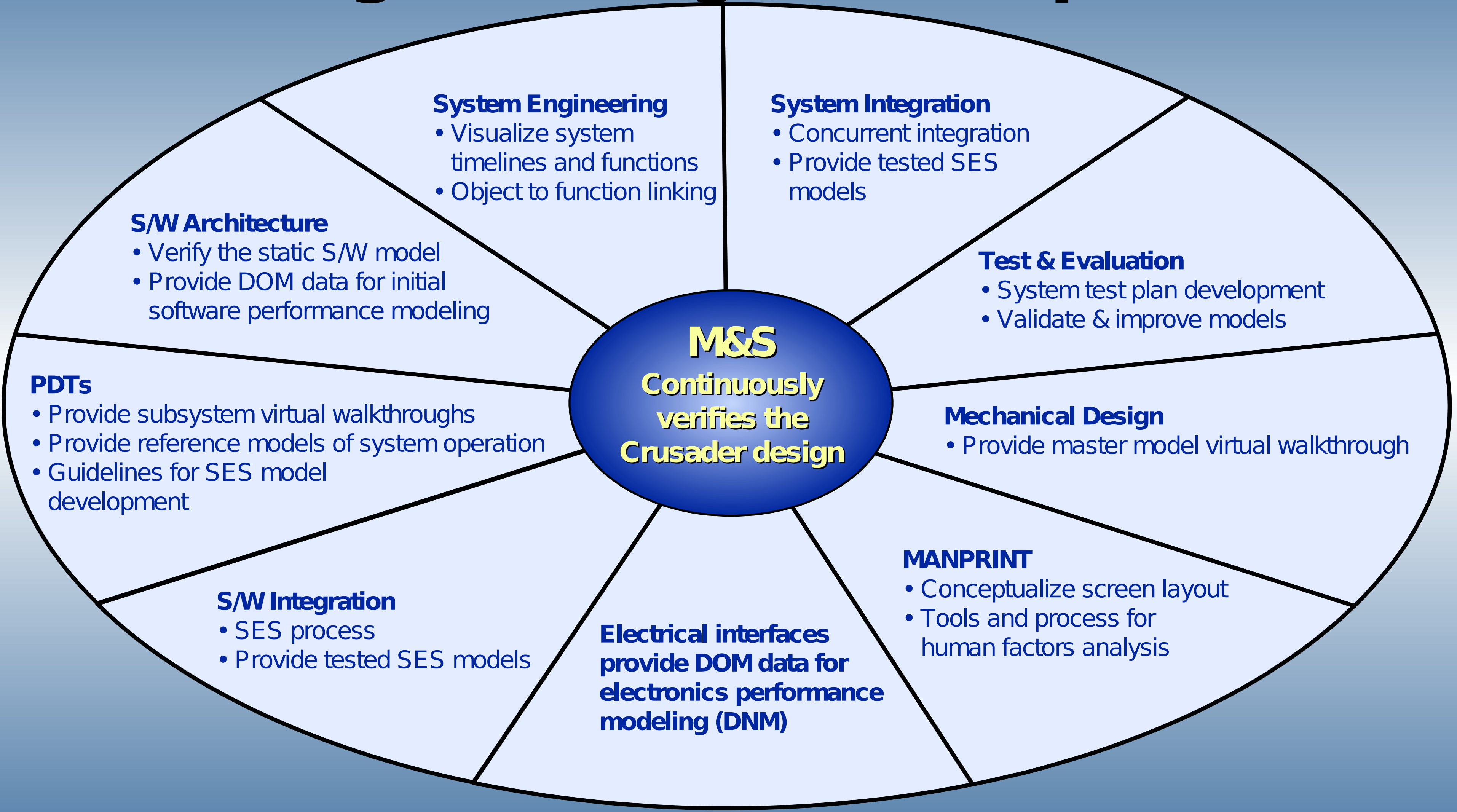
# The Many Facets of M&S

**M&S**

**A Cost-effective Approach To Continuous Design Verification and Optimization**

***M&S Brings Together Hardware, Software and The Human***

# M&S in Support of Engineering Development



**M&S**

**Continuously verifies the Crusader design**

**System Engineering**
- Visualize system timelines and functions
- Object to function linking

**System Integration**
- Concurrent integration
- Provide tested SES models

**Test & Evaluation**
- System test plan development
- Validate & improve models

**Mechanical Design**
- Provide master model virtual walkthrough

**MANPRINT**
- Conceptualize screen layout
- Tools and process for human factors analysis

**Electrical interfaces provide DOM data for electronics performance modeling (DNM)**

**S/W Integration**
- SES process
- Provide tested SES models

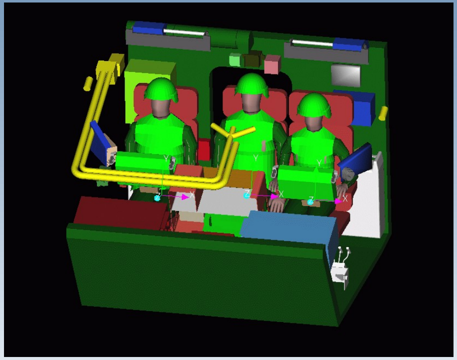
**PDTs**
- Provide subsystem virtual walkthroughs
- Provide reference models of system operation
- Guidelines for SES model development

**S/W Architecture**
- Verify the static S/W model
- Provide DOM data for initial software performance modeling

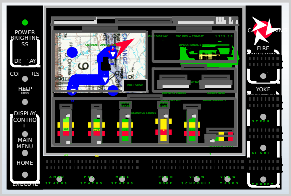
**M&S is concurrent integration**
**M&S brings together hardware, software and the human factor**

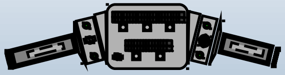
# MANPRINT Examples

- **Safework** - Human Modeling tool was used early in PDRR to ensure the emerging designs fully supported the soldier.
  - ✓ Crew Cockpit Layout
  - ✓ Egress/ingress
  - ✓ Access to weapon/cargo compartment
  - ✓ Maintenance Task

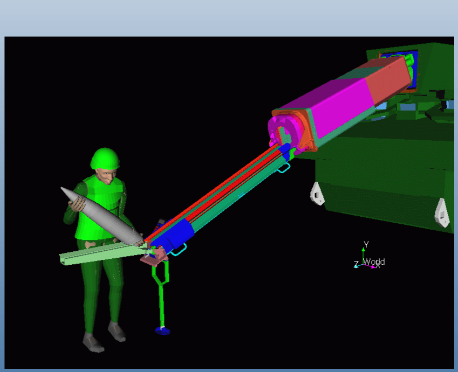


- **HARDMAN/IMPRINT** - Workload models are used to validate the Crusader Tasks and insure Human Computer Interface is fully compatible with the Crusader Target Audience



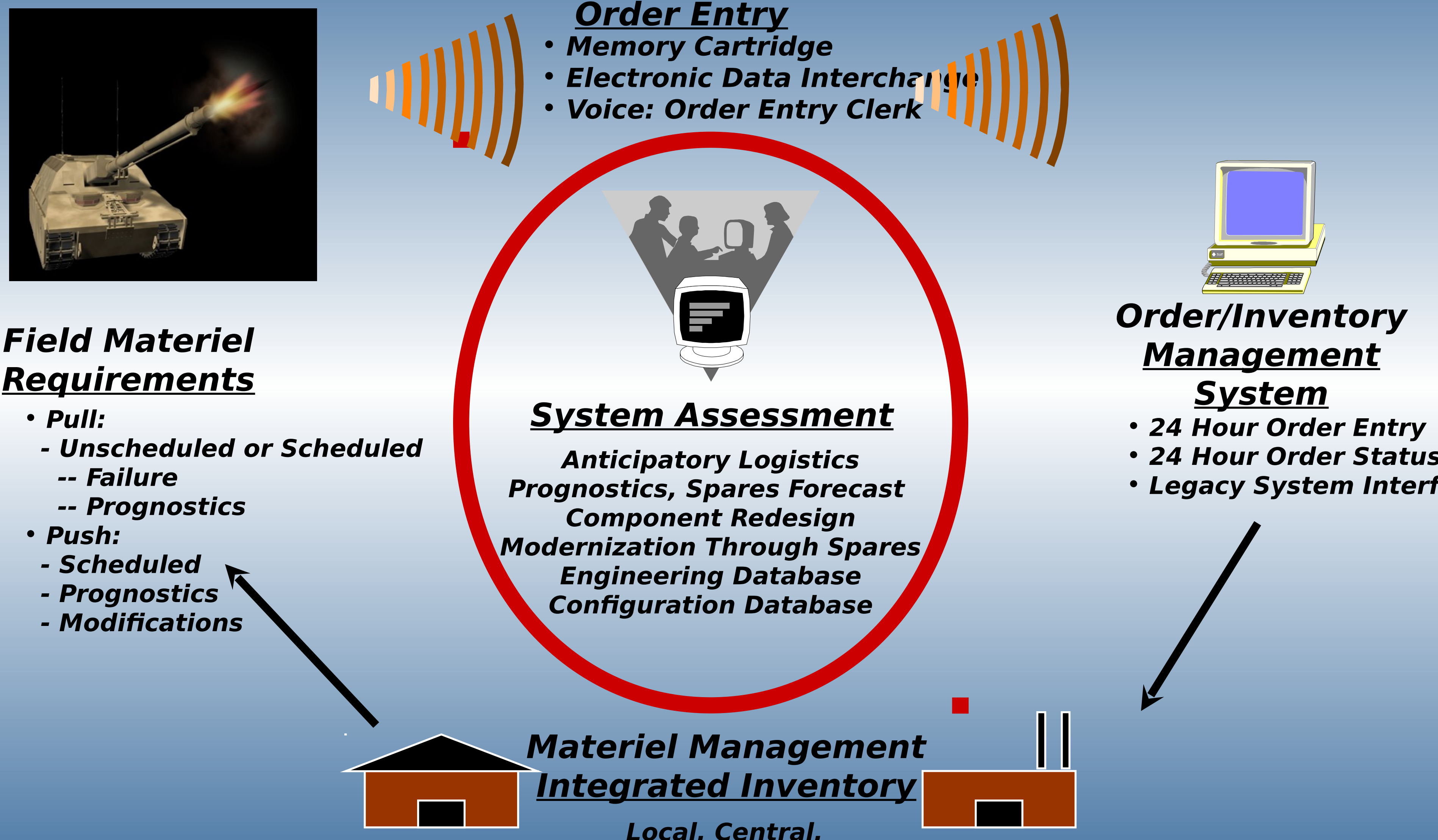


- **Hazard Tracking System** - Extensive Data Base which contains all identified Safety and Health Hazards.



- **VAPS** - Rapidly Prototype the Human

# Closed Loop Support System



## Order Entry

- Memory Cartridge
- Electronic Data Interchange
- Voice: Order Entry Clerk

## Field Materiel Requirements

- Pull:
  - Unscheduled or Scheduled
    - -- Failure
    - -- Prognostics
- Push:
  - Scheduled
  - Prognostics
  - Modifications

## System Assessment

Anticipatory Logistics
Prognostics, Spares Forecast
Component Redesign
Modernization Through Spares
Engineering Database
Configuration Database

## Order/Inventory Management System

- 24 Hour Order Entry
- 24 Hour Order Status
- Legacy System Interf

## Materiel Management Integrated Inventory

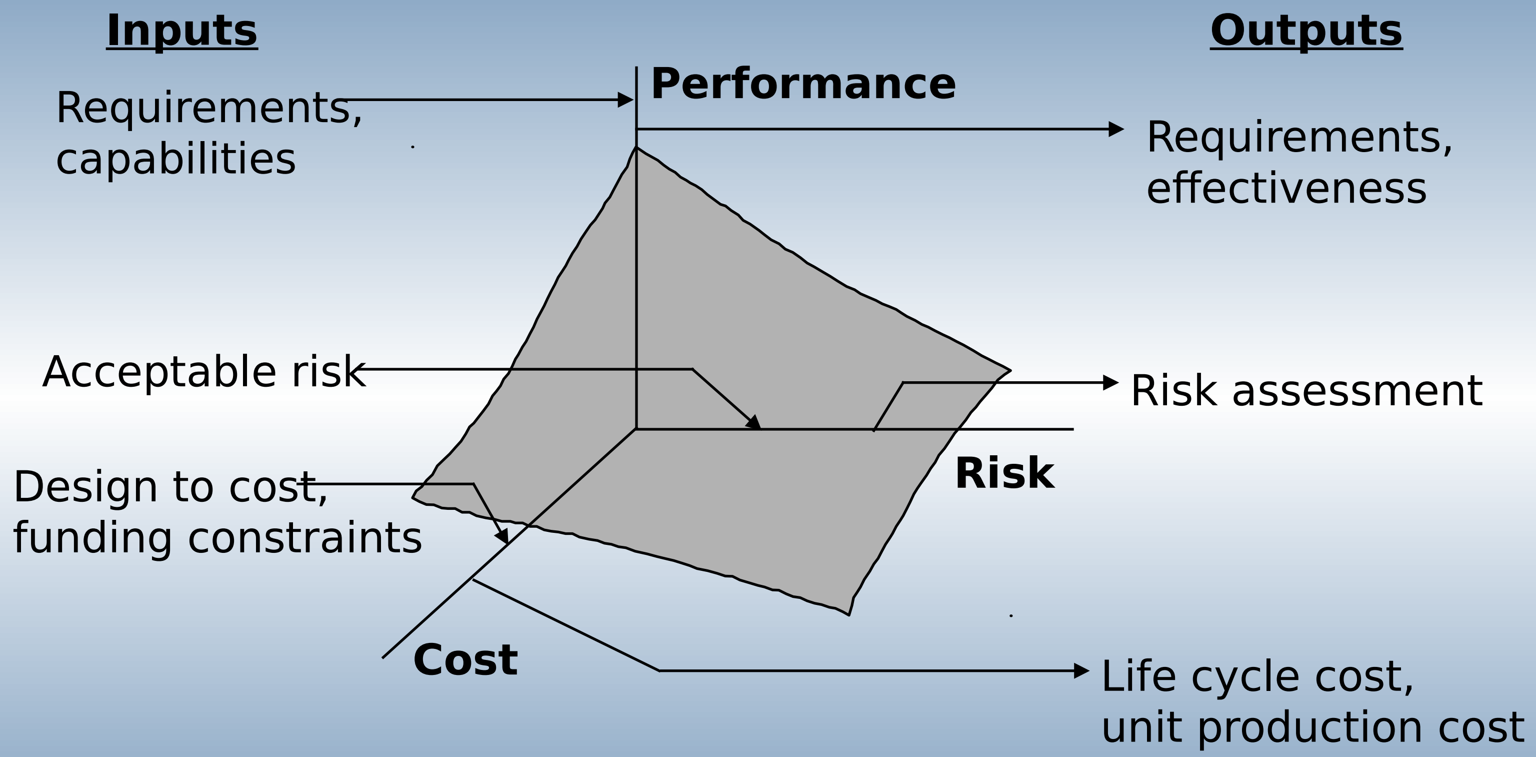
Local, Central,
Vendor, Production

# Simulation-Emulation-Stimulation (SES) Process

- **Supports:**
  - ✓ Hardware Development
  - ✓ S/W Development
  - ✓ System Integration
  - ✓ Test
  - ✓ Continuing Support Functions

- **Evolving Process:**
  - ✓ Initially, purely computational…
  - ✓ Then, some software and electronics in the loop…
  - ✓ Finally, actual prototype hardware & software
  - ✓ Incorporates user, environmental, and test inputs

# Requirements Methodology


Inputs
Requirements, capabilities
Acceptable risk
Design to cost, funding constraints
Performance
Risk
Cost
Outputs
Requirements, effectiveness
Risk assessment
Life cycle cost, unit production cost

**Knowing the cost, risk, performance relationships enables a search of feasible solutions for the optimal, cost effective system.**

# Requirements Methodology
## — Benefits—

- Resulting quick response tool helps leadership efficiently focus on key issues

- Impact of alternative courses of action assessed immediately

- Analysis/data collection process solidifies understanding of system level capabilities

- Traceability of impact on performance, cost, risk, and schedule to internal or external program changes

# Lessons Learned

- Unfunded mandates don’t work
- Commercial, off-the-shelf software tools have proven as important to reducing design cost as system specific M&S
- Can not make M&S and entity of its own
- Need to resource and not be scared off by the cost to do it right
- Funding instability/appetite suppression remains a big problem
- Must have a user jury with real users integral to the development of the collaborative environment
- Much harder to change than expected
- Collaborative requirements and spiral development embraced in principle, not fully practiced
- Speed is not free – demands upfront dollars
- Congress skeptical/suspicious

# Major Progress

- Many best practices and lessons learned documented
- Better tools and computing power
- Better education
- Actual Implementation and results
- Culture is changing
- Established processes
- RDE command is standardizing the way we do S&T and bringing the efforts into a collaborative environment

***M&S and a collaborative environment are a must in today’s environment and not just a better way to to business***

# Challenges

- Resourcing (Robust M&S effort and the collaborative environment is not cheap)
- Culture across the community
- Program evolution and M&S program must be in lock step, can’t let one get in front of the other
- Everyone has an opinion, must do what is right for each specific application
- A collaborative environment can not be affective if used a a tool to do business as usual

***Rule: One size does not fit all***

# Summary

- **Simulation Based Development Enables Significant Reductions In Program Development Cost, Schedule, and Risk**
- **Evolution of the Modeling and Simulation Approach From Simulation to Emulation to Stimulation Is Necessary to Support a Maturing Design**
- **A Successful Simulation Based Development Approach Requires:**
  - ✓ ***Partnering of the OPM/TSM/Stake holders/Developer***
  - ✓ ***An Effective Means of Managing and Communicating Large Amounts of Data From Many Different Sources***
- **M&S Concurrently Brings Together Hardware, Software and the Human**
- **Concurrent Design Verification and Integration**
- **M&S Provides Reference Models That Help People Understand the System**
- **M&S Provides Placeholders That Allow Integration Activities to Continue If Hardware or Software Is Not Yet Available**
- **End-to-end suite of simulations which will support Crusader through its life cycle**
  - ✓ **Post fielding improvements in hardware and software can be quickly and cheaply analyzed**
  - ✓ **Changes in Tactics Techniques and Procedures (TTP) can be readily evaluated**
  - ✓ **Troubleshooting will be quicker and easier using M&S**